



Correspondence

Comment on “A new electrocardiogram finding for massive pulmonary embolism: ST elevation in lead aVR with ST depression in leads I and V₄ to V₆”

To the Editor,

We have read with a great interest the article by Zhong-qun et al concerning electrocardiographic (ECG) changes in massive acute pulmonary embolism (APE) [1]. The authors presented 3 patients with APE and deterioration of clinical status during the hospitalization. They pay attention to a combination of the following electrocardiographic features: ST-segment elevation in lead aVR and ST-segment depression in leads I, V₄ to V₆ [1]. This ECG pattern may be helpful in patients with suspected or recognized APE in the rapid identification of high-risk patients who may benefit from thrombolytic therapy or mechanical intervention. In a study that we performed, the number of leads with negative T waves, the presence of right bundle-branch block, and ST-segment elevation in leads V₁ (odds ratio, 3.99; $P = .00017$) and aVR (odds ratio, 2.49; $P = .011$) were independent predictors of complications during hospitalization [2]. All 3 cases presented by Zhong-qun et al display QR (qR) sign (known as Kuschner sign) [3] with the different combination of subtle ST-segment elevation in leads III and/or aVR and/or V₁ and/or V_{3R}. The aforementioned ECG features and ST-segment depression in lateral leads observed by Zhong-qun et al are significantly more common in patients with elevated troponin vs patients with normal troponin level. Our study showed that ST-segment depression in V₄ to V₆ (40% vs 14%; $P = .001$), ST-segment elevation in III (22% vs 7%; $P = .0006$), V₁ and V₂ (43% vs 10%; $P = .0001$), and QR in V₁ (16% vs 5%; $P = .007$) were more common in patients with elevated troponin vs patients with normal troponin level [4]. More recently, we assessed the frequency of ST-segment elevation (STE) in lead aVR in patients with APE [5]. We found STE in lead aVR in 45.3% patients. In comparison with patients without STE, patients with STE in lead aVR had significantly more often systolic blood pressure less than 90 mm Hg on admission (27% vs 10%; $P < .001$) and positive troponin level (64.8% vs 27.9%; $P < .001$). Thrombolytic therapy (14.3% vs 5.6%; $P = .009$) and catecholamines (29.3% vs 7.5%; $P < .001$) were more frequently used in patients with STE in lead aVR. The overall mortality (16.5% vs 6.9%; $P = .009$) and complication rates during hospitalization (38.3% vs 12.5%; $P < .001$) were significantly higher in patients with STE in lead aVR [5]. The STE in lead aVR was significantly more frequent in patients with negative T waves in inferior leads, STE in lead III, STE in lead V₁, ST depression in lead V₄ to V₆, right bundle-branch block, QR sign in lead V₁, and S_I-Q_{III}-T_{III} sign [5].

We conclude that patients with APE and with the presence of STE in lead aVR and ST depression in leads V₄ to V₆ are at very high risk for complications and death during hospitalization. We congratulate Zhong-qun et al for this very important ECG observation.

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Performance improvement in emergency tourniquet use during the Baghdad surge[☆]

To the Editor,

Recently, we studied emergency tourniquet use, a vital need in war casualties, to stop bleeding, and knowledge generated helped to improve survival at a low risk of morbidity [1–3]. We sought to document the impact of process improvement efforts over time on tourniquet success rates, the use of other hemorrhage control measures in conjunction with tourniquets, and the rate at which prehospital tourniquets were converted to pressure dressings as

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Table 1
Tourniquet use results by survey period

Variable (unit)	Period				Comparison of period 3 to period 1
	1	2	3	Overall	
Duration (d)	200	167	99	466	
Limb count	309	342	301	952	
Casualty count	232	267	228	727	
Tourniquet device count	428	434	350	1212	
Survival rate (%)	86.6	86.9	90.8	88.0	$P = .16$
Survivor count	201	232	207	640	
Death count	31	35	21	87	
Prehospital use rate (%)	84	86	97	89	$P < .0001$
Use rate before shock onset (%)	96	96	99	97	$P = .035$
Appropriate wound indication rate (%)	96	99	99	98	$P = .021$
Tourniquet use rate distal to a proximal wound (%)	1	1	2	1	$P = .5$
Loose tourniquet use rate (%)	4	8	9	7	$P = .03$
Breakage or malfunction rate (%)	2	1	0	1	$P = .05$
Rate of limbs with only 1 tourniquet used (%)	66	74	89	76	$P < .0001$

doctrine suggests [4]. The 3 sequential periods surveyed corresponded to the precondition, the preparation, and the execution of the Baghdad surge; in comparison with the 2 previously reported periods, we report the third period now. The purposes of the present study are to (1) survey tourniquet use to fill knowledge gaps in casualty care in the current period and (2) compare results of the 3 periods to provide a model of implementing tourniquet use locally to civilian emergency medical systems.

We continued a protocol of a clinical survey of war casualties with tourniquets used at a US military hospital at Ibn Sina Hospital in Baghdad, Iraq [1–5]. The study period of the current report was March 23, to June 30, 2007 (99 days), which was the third sequential period to which the prior 2 were compared [1,2].

In the Third Survey Period, the surveyed group included 228 casualties (213 males [93%], 15 females [7%]). The 350 tourniquets were used on 301 limbs (148 left, 153 right; 204 lower, 97 upper). The case accrual rate was 2.3 casualties with tourniquets used per day for the 99-day survey (228/99, Table 1).

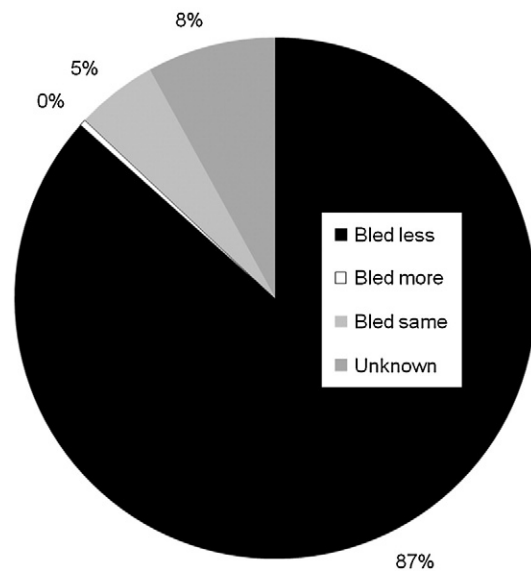


Fig. 2. Proportion of limbs by wound bleeding response to initial tourniquet use.

In addition to tourniquets, field dressings (routine gauze) were used in 62% (188/301) of the casualties (Fig. 1). The high proportion (18%, 55/301) of nonuse (ie, no other hemorrhage control measure used) may indicate that tourniquets were the first option for use during care under fire in compliance with military doctrine that tourniquets are the only hemostatic device to be used while under fire. Response to the tightening of the first tourniquet was that 87% of limbs bled less (262/301), 0.3% of limbs bled more (1/301), 5% of limbs bled the same (14/301), and data were not recorded in 8% of limbs (24/301, Fig. 2). Tourniquets were released a single time in 86% (260/301) of limbs and twice in 11% of limbs (33/301; 8/301 unrecorded). Systolic pressure in 2% (7/301) had 30 mm Hg or more drop in systolic blood pressure after tourniquet release, perhaps indicating loss of hemorrhage control from a distal wound.

The 3 survey periods had a total 727 casualties with 1212 tourniquets (Tables 1 and 2, Figs. 3 and 4). Casualty demographics were similar in each period. From periods 1 to 3, the rate of tourniquets per day rose 65% (2.14–3.54), the rate of limbs with

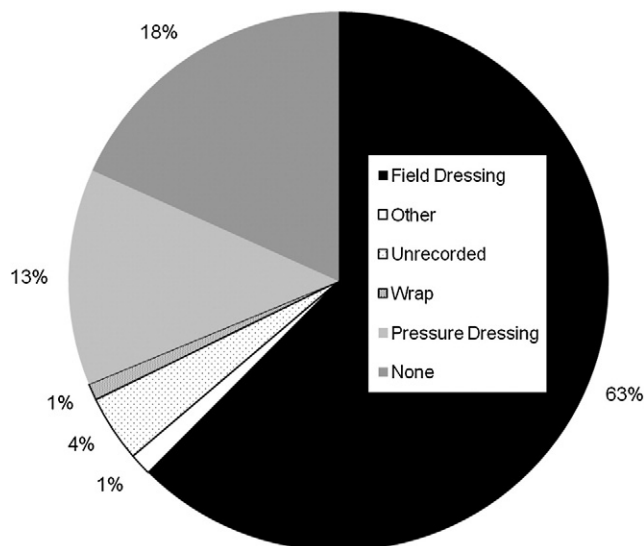


Fig. 1. Proportion of limbs with tourniquets and other hemorrhage control measures.

Table 2
Findings of changes in current vs prior tourniquet use

Changes in tourniquet use
Increased rate of tourniquets used per day
Increased proportion of casualties with tourniquets per day
Increased proportion of limbs with tourniquets per day
Increased diversity of casualties with tourniquets (more nationalities and civilians represented)
Increased proportion of indicated tourniquet use (decreased misses of indicated casualties)
Increased proportion of casualties with prehospital tourniquets used
Increased proportion of casualties with tourniquets used before shock onset
Increased proportion of appropriately used tourniquets
Increased proportion of loose tourniquets
Increased proportion of commercial tourniquets used (decreased improvised tourniquets)
Increased proportion of limbs with hemorrhage control by effective tourniquet use
Increased proportion of limbs with only one tourniquet needed
Decreased proportion tourniquet used with tourniquet breakage or malfunction

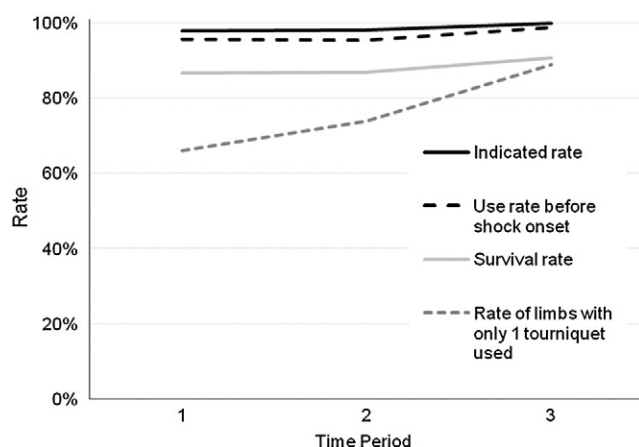


Fig. 3. Trend rates of tourniquet use and outcome by period.

tourniquets per day rose 97% (1.55–3.04), and the rate of casualties with tourniquets per day rose 99% (1.16–2.30).

The main finding of the current study is that the results indicate growing breadth, depth, and utility of emergency tourniquet use. For example, more frequent and earlier use of emergency tourniquets was associated with improved clinical performance. The work of serious quality improvement in tourniquet use was incremental, arduous, and sustained in what has been described as the most chaotic and stressful environment imaginable for doing science [6]. The military services used tourniquets more often in later periods to try saving all lives possible by not missing anyone needing limb hemorrhage control [3]. As we managed the military's emergency tourniquet program, we monitored the miss rate of US casualties with isolated limb exsanguination (including no tourniquet use and death), and the rate has been nearly zero for some time now. Lessons learned from the current study, if broadcast widely, may improve performance elsewhere.

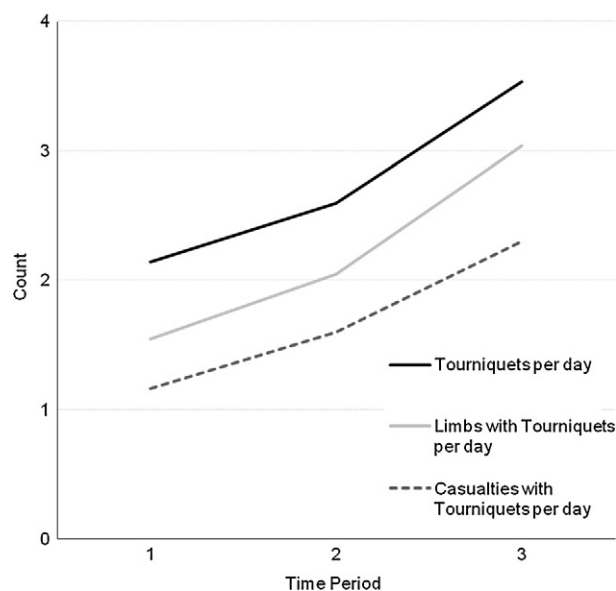


Fig. 4. Tourniquet use rates by period.

Another finding of the current study is that trends of tourniquet use earlier, more often, and more effectively in the care of casualties were associated with improved clinical performance and outcomes. The increased rate of tourniquets used per day and per casualty indicated a growing reliance on tourniquets for hemorrhage control on the current battlefield.

Given the large number of emergency tourniquets already purchased by civilians, the results of the present study provide an opportunity to inform and improve care outside military use. Specifically, these data support emphasis on early use. The experience of Arizona's Pima County deputy sheriffs' response to the shooting of 19 people in 2001 near Tucson offers anecdotal evidence that these devices can be used successfully by nonmedical first responders [7]. More frequent and earlier use of emergency tourniquets was associated with improved clinical performance. These findings fill specific knowledge gaps in casualty care to help refine best practices, first-aid doctrine, and tourniquet training.

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